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THE ROCKY MOUNTAIN LOCUST.[1]

BY C. V. RILEY, PH. D.

THE subject which you have assigned to me is entitled The Rocky Mountain Locust and the Army Worm. Both these insects are extremely injurious to the agriculture of the United States, and as it would be difficult to do justice to both in the compass of a brief address I shall confine my remarks at the present time to the first named. So much has been written and said, by myself and others, upon this Rocky Mountain locust during the past two or three years that it would seem difficult indeed to say anything about it that is new or of value. Yet I may safely assert that most of the definite and accurate knowledge regarding its habits and life history was first given to the world during the present year.

Though popularly known as the "grasshopper," yet the term "Rocky Mountain locust," proposed by myself, has been very generally adopted as most appropriate. The insect belongs to the same family as the locusts of Scripture. The term grasshopper is very loosely applied to many insects that hop about in grass, but strictly belongs to the long-legged, long-feelered species. Locusts have short and stout legs, short and stout feelers, and are mute, or, if they stridulate at all, do so by rubbing the hind thighs against the sides of the folded front wings; their prevailing color is brown; they are gregarious, and they oviposit in the ground by means of short, drilling valves. True grasshoppers have long and slender legs and feelers, and stridulate by vibrating the front wings, which in the males are furnished, generally near the base, with talc-like plates crossed by enlarged and hollow veins; their prevailing color is green; they are solitary, and they mostly oviposit in different parts of plants, by means either of a sword- or scimeter-shaped ovipositor. It is the grasshoppers, the katydids (which are a tree-inhabiting section of them), and the crickets which make field and wood resound with shrill orchestry at the present season; but the locusts take no part in the concert. While our insect belongs, therefore, to the same family as the locusts of Scripture, those people are greatly at sea who imagine it to be specifically identical with any of the Asiatic or European species. It is known to entomologists as

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[1] An address delivered at the Chicago session of the American Agricultural Congress, in September, 1877. Some portions are omitted for want of space. — ED.

Caloptenus spretus, and is purely American, since it does not inhabit any other continent.

Evolutionists believe — and I am one of them — that existing species are but the modified descendants of preëxisting species. The present species of a genus have at some time, more or less remote, had a common ancestry. All life exhibits a certain power of adaptation to surrounding conditions, and through what is known as "natural selection" (two words which by Darwin's pregnant pen have come to express volumes of facts and consequences), coupled with other less easily formularized laws, the fauna and flora of the globe have been as profoundly changed as have its physical conditions. The influences that have thus worked in the past are still working at present — less rapidly, perhaps, in the main, but none the less effectually. Among higher and more complex animals the changes are slow and not very noticeable; the species have become, in most cases, markedly differentiated, and their characters are well fixed. Among lower organisms these changes are more obvious, and naturalists are sorely puzzled in their endeavors to grasp and express them. This is especially the case among insects. We have the simple variation from the typical characters of a species; we have phytophagic varieties, or those departures from the type that result from the kind of food assimilated during growth; we have phytophagic species, or those variations which have become fixed and permanent in the adolescent or immature stages through some peculiar and fixed habit, without having yet modified the imago or mature state; we have geographical variation, increasing — usually with distance — until the separation from the type is sufficient to be indicated by what we call race; we have seasonal variation, sexual variation, and, finally, we have the terms dimorphism, heteromorphism, and many other *isms*, to express still other variations. In short, in the strain, the breed, the sport, the tribe (in the popular sense), the variety, and the race, we have so many terms invented to indicate some of the more patent steps in the evolution of one species from another, and between them all there are so many shades of variation for which no words have yet been coined, that the naturalist who takes a comprehensive view of life upon our planet finds that what we have chosen to call *species* are often with difficulty separated from each other; that they have, in fact, no real existence in nature. All our classificatory divisions are more or less conventional. They are excellent as aids to thought and study, but misleading when believed — as they popularly are — to express absolute creations that have existed for all time.

As with other species, so it is with the locust under consideration. The species is a denizen of the plains regions of the Rocky Mountains to the west and northwest of us. It breeds continuously and comes to perfection only in those high and dry plains and prairies; and though at intervals it overruns much of the lower, moister country to the east and southeast, yet it never extends in a general way to the Mississippi. But there are species east of the Mississippi that are so closely allied to it that the ordinary farmer cannot, without a little special knowledge, appreciate the difference, and entomologists, even, are not of a mind as to whether they should be called species, varieties, or races, etc. The two species most closely allied to the Rocky Mountain locust are the red-legged locust (*Caloptenus femur-rubrum*) and the Atlantic locust (*Caloptenus Atlantis*). Both are wide-spread species, but are either rare or do not occur in the home of *spretus*. The differences between the three species I have elsewhere given in detail; for the present purpose it suffices to say that the distinguishing characters, most easily observed by the non-entomologist, are the relative length of the wing and the structure of the terminal joint of the male abdomen. The Rocky Mountain species has the wings extending, when closed, about one third their length beyond the tip of the abdomen, and the last or upturned joint of the abdomen narrowing like the prow of a canoe, and notched or produced into two tubercles at top. The wings of the red-legged locust extend, on an average, about one sixth their length beyond the tip of the abdomen, and the last abdominal joint is shorter, broader, more squarely cut off at top, without terminal tubercles, and looks more like the stern of a barge.

The Atlantic locust, though smaller than either, is in other respects intermediate between the two, but in relative length of wing and structure of the anal joint in the male, most related to *spretus*.

We should encourage the locust's natural enemies. Practically this is not possible with many of the smaller parasitic and predaceous kinds; they are beyond our control. With many of the larger locust enemies, however, as in the case of birds, it is feasible. One of the most effectual ways of accomplishing it is to offer a reward for hawk-heads, as Colorado has done. The introduction of such hardy locust-feeding birds as the grackle and the

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ters of agriculture and of the interior, and

with Governor Morris, on the subject, and they see nothing impracticable in the plan. We have on this side the line a number of signal stations and military posts in the country where the insect breeds. Now, I would have our own military force coöperate with the Dominion police force as a locust vigilance committee. Under the intelligent guidance and direction of some special commissioner or commission, I would have that whole country systematically studied every year by such a force, with reference to the abundance or scarcity of the locusts. I would have such a vigilance force, by a proper system of fire-guards and surveillance, prevent the fall fires in sections where the insects or their eggs were known to abound, in order to burn them at the proper time the following spring; and where such precaution was not possible or had failed, and the winged insects at any season were numerous, I would have their movements carefully watched, and communicated daily to the signal officers, to be by them communicated to the farmers. In this way the latter could be fully forewarned of approaching danger. I would have the Western farmers adopt some general plan of defense against possible invasion. The straw that is now allowed to rot in sightless masses as it comes from the thrasher, and that encumbers the ground unless burned, should be utilized. Let it be stacked in small pyramids at every field corner, and there let it remain until the locusts are descending upon the country. Then let the farmers in a township or a county, or in larger areas, simultaneously fire these pyramids, using whatever else is at hand to slacken combustion and increase the smoke, and the combined fumigation would partially or entirely drive the insects away, according as the swarm was extended or not. In short, not to weary you, I believe, first, that by proper coöperation on the part of the two governments interested, the excessive multiplication of this destructive insect may be measurably prevented in its natural breeding-grounds, and that the few thousand dollars that would be necessary to put into operation intelligent coöperative plans were most trifling in view of the vast interests at stake. In fact, with an efficient and properly organized department of agriculture, liberally supported by Congress, and aided by the war department and the signal bureau, the plan could soon be perfected and carried out at minimum expense. I believe, secondly, that where the insect's multiplication cannot be prevented in its natural breeding-grounds our farmers in the more thickly-settled sections may, by the use of smoke, measurably turn the course of invading swarms and protect their crops,— obliging the insects to resort to the uncultivated areas.

Were the injury to continue for another three or four years as it has for the past four, and were the Western farmers to suffer a few more annual losses of forty million dollars, such schemes as I have suggested would soon be carried out. The danger is that during periods of immunity, indifference and forgetfulness intervene until another sweeping disaster takes us by surprise.

Rules greatly assist in the solution of any problem, and in proportion as we get at a knowledge of the laws governing this Rocky Mountain locust shall we be able to overcome it. The country which it devastates is so vast, and the question as to its origin and the causes of its disastrous migrations is so complicated, that a limited study is apt to beget doubt as to whether there are any laws governing the insect or any rules for our guidance. The facts of sociology are so innumerable that the ordinary gleaner of them reaps but confusion. It requires the genius and comprehensiveness of a Herbert Spencer to deduce principles therefrom,— to perceive the laws by which society is molded. The vain, delusive confidence begot of first study of any difficult subject — that follows superficial knowledge,— reacts in doubt and diffidence upon deeper delving and more thorough study.

"The more I learn the less I know" is a paradoxical but very common remark. It is only after passing through this period of doubt in any inquiry that we can begin to see the light; and in this locust inquiry it is only after accumulating facts and experiences until they almost overwhelm us with their complexity that we can begin to generalize and deduce rules.

The history of this insect east of the Rocky Mountains, when viewed from a comprehensive stand-point, presents certain well-marked features. We have, first, the migrations of winged swarms in autumn from the higher plains of the West and Northwest, into the more fertile country south of the 44th parallel and east of the 100th meridian. It is the more fertile and thickly-settled country south and east of the limits indicated which suffers most, both from the insects which sweep over it and from the young that hatch in its rich soil; and it is principally this country which I have designated as being outside the insect's native home, and in which it can never become a permanent resident. The species does not dwell permanently even in much of the country north and west of those lines, but it flourishes more and more toward the northwest. In short, the vast hot and dry plains and prairies of Wyoming, Dakota, and Montana, and the immense regions of a similar character in British America, comprising what is known as the third prairie plateau or steppe, are congenial breeding-grounds, and supply the more disastrous swarms which devastate the lower Missouri and the Mississippi valleys. That northwest country may be depicted as a vast undulating prairie sea, now stretching in sandy barren tracts which bring forth little else than the cactus or sage-bush; now rolling for hundreds of miles, and covered with the buffalo grass (*Bucloe dactyloides*) and other short nutritious grasses, and again producing a ranker prairie growth wherever there is increase of moisture. Another peculiarity of that country is that though the spring opens as early, even away up in the valley of the South Saskatchewan, as it does in Chicago, yet the vegetation often becomes parched up and burned out by the early part of July. Now, *Caloptenus spretus*, though coming to perfection in high and dry regions, is nevertheless fond of succulent vegetation, and instinctively seeks fresh pastures whenever those of its own home are dried up. It may sometimes happen, indeed, that the species will die in immense numbers if the scant vegetation where it breeds should dry up before the acquisition of wings, just as another species (*Œdipoda atrox*) has perished in immense numbers the present season in California by the excessive drought that has prevailed there; but ordinarily the insects will be full grown and fledged before the parched season arrives, and the ample wings of the species prove its salvation. Again, it may become so prodigiously multiplied during certain seasons that everything green is devoured by the time its wings are acquired.

"In either case, prompted by that most exigent law of hunger, — spurred on for very life, — it rises in immense clouds in the air to seek for fresh pastures where it may stay its ravenous appetite. Borne along by the prevailing winds that sweep over these immense treeless plains from the northwest, often at the rate of fifty or sixty miles an hour, the darkening locust clouds are soon carried into the moist and fertile country to the southeast, where with sharpened appetites they fall upon the crops, a plague and a blight. Many of the more feeble or of the more recently fledged perish, no doubt, on the way; but the main army succeeds, with favorable wind, in bridging over the parched country which affords no nourishment. The hotter and dryer the season, and the greater the extent of the drought, the earlier will they be prompted to migrate, and the farther will they push on to the east and south."[1]

We have, second, the return migration toward the northwest from the country south and east of the lines already indicated, of the progeny of invading swarms, as soon as wings are acquired the next summer. Time will not permit me to present the explanation of this return migration. In the work just quoted I have discussed its causes, the reasons why the species cannot permanently thrive in the Mississippi valley, and the conditions which prevent its establishment there.

We have, third, the eastern limit of the insects' spread along a line broadly indicated by the 94th meridian, and the consequent security from serious injury east of that line.

These three features of our disastrous swarms — the return migration from the southeast country (which implies only temporary injury therein), and the eastern limit, — may be stated as laws governing the insect east of the Rocky Mountains. They have constantly been urged by me, and the present year's experience has confirmed and verified them. I think I may safely present a fourth, namely, that the eggs are never laid thickly two successive years in the same regions.

In mapping out the country in Kansas and Missouri in which eggs had been laid most thickly in 1876, I was struck with the fact that the very counties in which the young insects had been most numerous and disastrous in 1875 were passed by or avoided, and had no eggs of any consequence laid in them in 1876. The fact was all the more obvious because the insects did much damage to fall wheat, and laid eggs all around those counties, to the north and south and west. From the exhaustive report on the insect in Minnesota, made by Mr. Allen Whitman, it was also very obvious that those portions of that State which had been most thickly supplied with eggs in 1875, and most injured by the young insects in 1876, were the freest from eggs laid by the late swarms of the latter year, notwithstanding counties all around them were thickly supplied. I was at first inclined to look upon these facts as singular coincidences only; but instances have multiplied. A remarkable one has been furnished me by Gov. A. Morris, of the northwest territory. You are well aware that in 1875 the locusts hatched out in immense numbers and utterly destroyed the crops in the province of Manitoba. Now, in 1876 they were very numerous over all the third prairie steppe of British America, and largely went to make up the autumn swarms that came into our own country a year ago. Governor Morris started late in July of 1876 from Winnipeg northwest to make a treaty with certain Indians, and during the first five or six days of August he encountered innumerable locust swarms all the way from the forks of the two main trails to Fort Ellice. The wind was blowing strong from the west all the time, — just the very direction to carry the insects straight over into Manitoba. The governor watched their movements with the greatest anxiety, fearing that the province would again be devastated as it had been the previous year. Yet during all the time he was passing through the immense swarms, they bore doggedly to the south and southeast, either tacking against the wind or keeping to the ground when unable to do so. Nothing was more remarkable than the manner in which they persisted in refusing to be carried into Manitoba. A few were blown over, but did not alight, and the province seemed miraculously delivered. Mr. Whitman tells me, again, that in settling the present year the insects avoided those counties in Minnesota in which they had hatched most numerously and done greatest injury, but selected such as had not suffered for some years past.

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[1] Locust or Grasshopper Plague, page 57. Rand, McNally, & Co., Chicago.

It is evident that there is more than mere coincidence in these occurrences, and I may say that upon looking more deeply into the matter I cannot find a single instance where eggs have been laid thickly for two successive years in any invaded country. This is a most important fact. During a season of great devastation there is a natural tendency among the more pious portion of the community to beseech the Almighty, by prayer, fasting, and humiliation, for deliverance. How greatly their faith must be strengthened by facts such as I have just stated! As a naturalist it is my province to study the reasons for the facts. Whether what I call the working of natural laws be called by others the instrumentality of Providence is quite immaterial.

To recapitulate, I think we may safely deduce the following four rules as governing the Rocky Mountain locust east of the mountains from which it takes its name: —

(1.) The northwest origin of the more disastrous fall swarms that overrun the more fertile country south of the 44th parallel and east of the 100th meridian.

(2.) The return migration toward the northwest of the insects that hatch in the country named.

(3.) The eastern limit of the insects' spread along the 94th meridian.

(4.) No two successive hatchings of an extensive and disastrous nature can take place in the same region.

The possibility of exception to the rules would be in keeping with the character of all rules; but I am convinced that the exceptions will ever prove most trifling. Now there is a deal of satisfaction to be drawn by our farmers from these rules, which not only limit locust disaster but enable them to anticipate events; and I need hardly state that the accuracy of my own prognostications, repeatedly made during the past three or four years, was in no small degree due to them.

We have had the spectacle of the Rocky Mountain locust, in what I call the return migration, flying over some parts of the vast territory from the 29th parallel to the Dominion boundary line, and from the 94th meridian to the mountains, all along from the end of April till the beginning of August, and with so little injury that, with the exception of the case in Montana, just mentioned,[1] the question everywhere asked is, Where have the flying 'hoppers gone? What has become of them? I answer that, as in previous years, and as I have always held would be the case, they were, in the main, so diseased and parasitized that they dropped in scattered numbers and mostly perished on their northward and northwestward journey. This is no theory, but known to have been the case in the more thickly-settled parts of Kansas, Nebraska, Iowa, and Minnesota, from which the insects that had dropped have been reported, and in some cases sent to me. But as the flight is for the most part over the vast and thinly-settled plains of Indian Territory, Kansas, Nebraska, and Colorado, the number that has dropped and been lost to sight in said plains is infinitely greater than that which has been observed to come down in the more thickly-settled regions to the east.

The more dense and extensive swarms that flew before the 1st of July reached, I have little doubt, the great thinly-settled plains and prairie region of Northwest Minnesota, Dakota, Montana, and British America, — embracing in the latter case most of the country between the projected line of the Canada Pacific and the boundary line, and between Manitoba and the Rocky Mountains. I found the insects sparsely spread over the rank prairies west of Brainerd along the Northern Pacific and along Red River; and by this I mean that a few would hop from the grass at every step, wherever I searched for them. I met with only here and there a straggler in Manitoba; but early in July they flew from the south over the country west of the province, and reached the North Saskatchewan at several points, passing many miles north of Fort Carleton.

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[1] Referred to in the portions omitted. — ED.

The insects that rose after the first week in July (mostly from restricted parts of Minnesota and Dakota) bore for the most part southwardly, while many of those which passed to the northwest earlier in the season returned. Thus, swarms more or less scattering have been passing for the past two months over parts of Iowa, Nebraska, and Kansas, in varying directions, but mainly to the south and southeast. They have lately reached into the Indian Territory. In no instance have they done serious damage, and the reports that come to me are singularly unanimous on this point. The movements of the insects that bred in Minnesota this year were very similar to the movements of those that bred there in 1876. They at first flew to the northwest, but were subsequently brought back, and traveled over parts of Iowa, Nebraska, and Kansas. The difference between the two years is that the flights that thus turned back on the original course in 1876 were recruited and followed by immense and fresh swarms from the northwest plains regions, where, far beyond the boundary line, they hatched and bred innumerably; whereas the Minnesota swarms of 1877 have not been recruited because there were few eggs laid in 1876, and no insects of any consequence reared in 1877 in said northwest country. It is upon this fact that I have founded the belief in no serious devastation in the southeast country this fall.

To those who pay little attention to the subject the disappearance of the swarms that left the Mississippi Valley is matter for wonder. " What is hit is history, but what is missed is mystery." Who, at the explanation of some simple trick or piece of legerdemain, has not smiled to think how easily he was baffled! But there are those who prefer the mystery of ignorance, and would much rather believe that the locusts have vanished in the heavens or been swept into the ocean than accept any explanation; and there are others who, from sectional feelings, would much rather believe that the insects have flown to Canada and New England than accept the facts.